

3. INTERMODAL MANAGEMENT SYSTEM GIS AND USER INTERFACE

Development of the IMS Geographic Information System (GIS) has been a major component of the IMS project. The first section of this chapter discusses the process of building the GIS. Included in the discussion are a description of the production of the base map, building of the routing systems, developing and testing the TransCad Add-ins as well as the layers used in the GIS, and finally an evaluation of the data available for use within the GIS from Federal sources. The second section examines the GIS user interface and its capabilities.

3.1 Development of the GIS

3.1.1 The Base Map: GDS to TransCad conversion

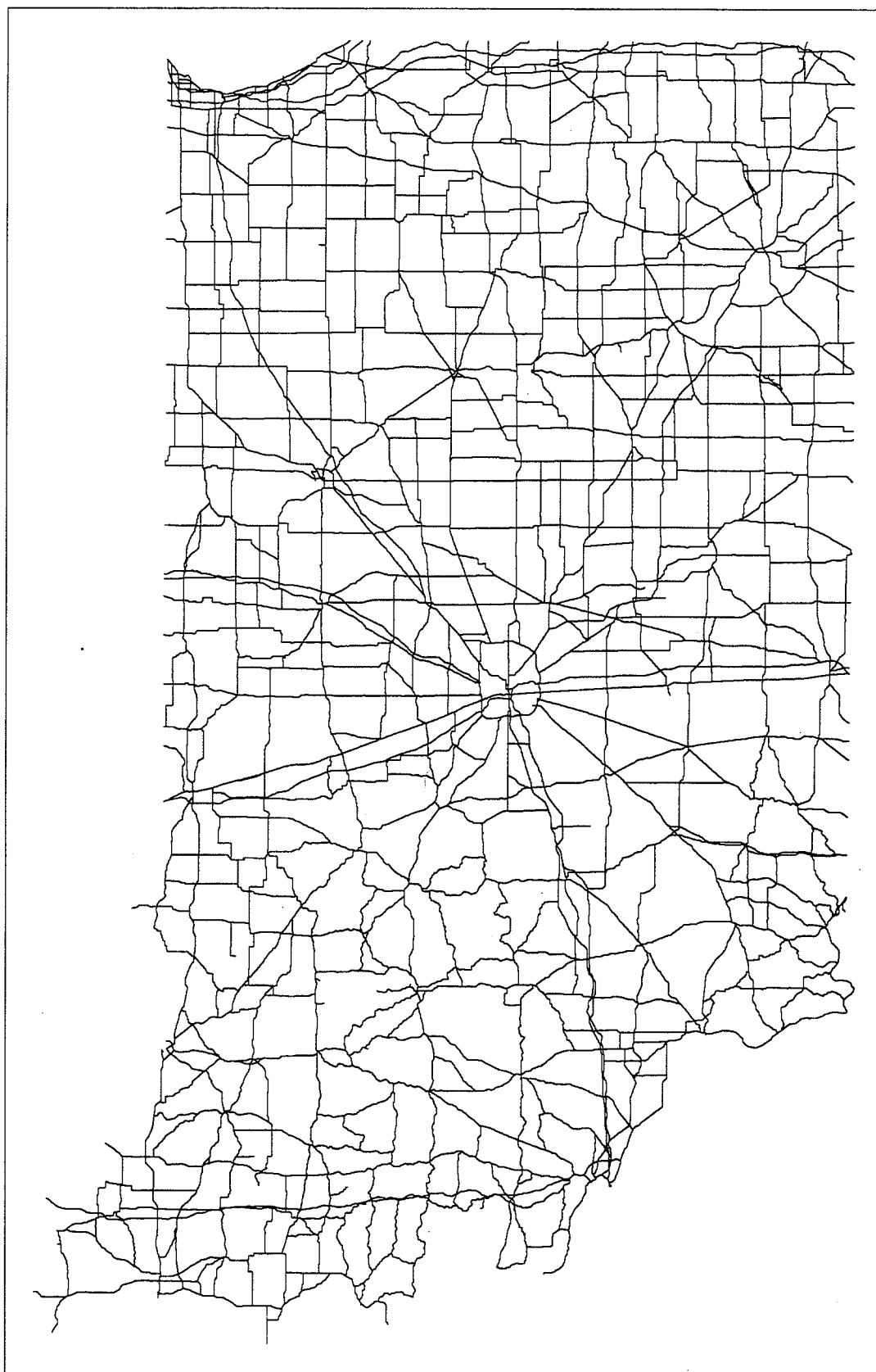
The base map providing the foundation for the GIS effort was obtained from the Engineering Graphics section at INDOT. This was the State highway base map used for the CASPER snow removal system network for INDOT. Since it was in the GDS format, a conversion to TransCad was necessary. Due to the earlier TransCad work performed under Professor Black in the Commodity Flow GIS analysis and the ease of use of the TransCad package it was decided to use this package in the IMS. Thus the decision was made to use TransCad software as the GIS platform for the project. GIS-Trans Ltd was selected to undertake the conversion effort.

The conversion process involved exporting the GDS map into ARCINFO format, running several utilities to establish network connectivity, and finally exporting to a format compatible with TransCad. The conversion process included a simplification of the state highway network. Interchanges and ramps were generalized into simple intersections. One-way pairs were also generalized into single two-way links.

The base map featured on the next page includes the entire inventory of roads that are designated as Interstates, U.S. routes, or State routes within the state. The map also includes a few selected local roads that are either a part of the National Highway System (NHS) or are old state routes that have been relinquished from State to local jurisdiction.

There are approximately 4,000 links in the base network. Most links consist of road segments that travel from one highway junction to another. However, the network does contain a sizable number of extra nodes, creating more links than are necessary. This is due to the fact that the original GDS map contains detailed ramp and interchange information that was removed in the conversion process. The nodes from these places were not removed. Additional nodes are in the network due to other information that was relevant in the GDS system (e.g. snow plow turn

Indiana Highway Network



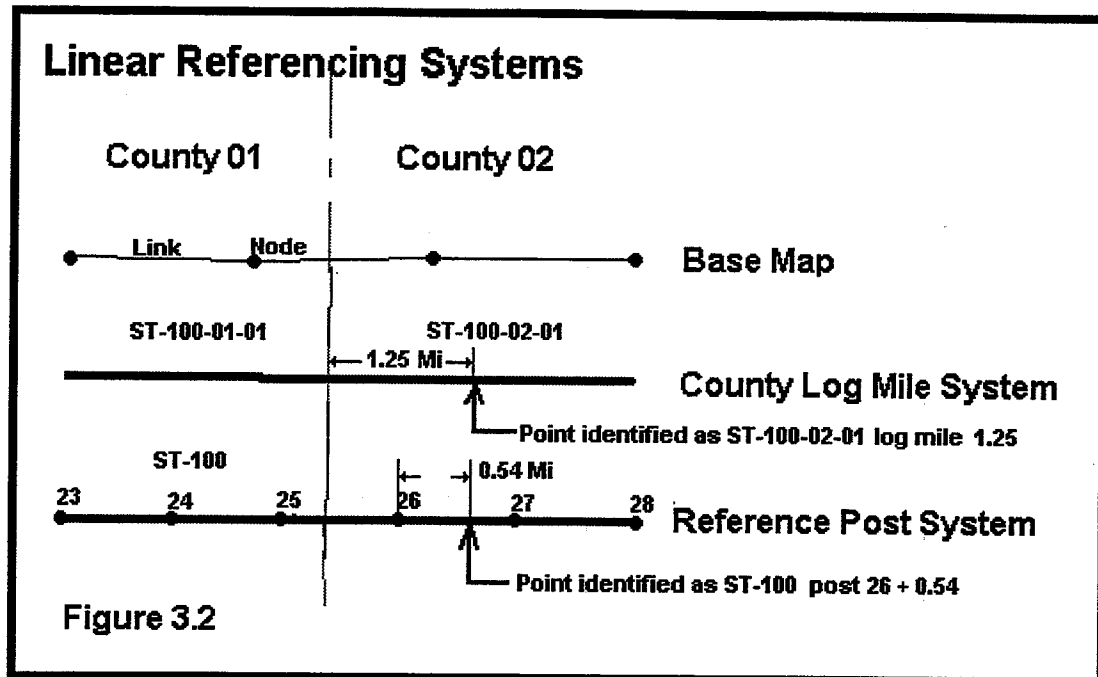
around points) but has no meaning in the current GIS. The extra nodes, while unnecessary, do not pose a problem in the new system.

3.1.2 Routing Systems

Currently, INDOT is using two independent linear referencing systems. The original system uses an assemblage of routes that are based on county log miles. This system is used for the State and local road inventory files. The second routing uses reference posts along state-wide routes and is used for data collection and analysis in the pavement management system.

In the County Log system, each route has a unique name based on the route type, route number, county number, and route section number. The unique name or a route changes as it crosses from one county to another. For example, State Route 37 in Boone County (county number 6) is called ST-037-06-01, when the highway passes into Marion County the unique name changes to ST-037-49-01. Data is referenced to this system by specifying the unique route name and then the county log mile location. County log miles are measured starting either from the south or west border of the county (see Figure 3.2).

In the Reference Post system, the routes are continuous across county lines and can be identified with just the route name. In the case of the previous example with State Route 37, it would simply have the unique name ST-037, anywhere in the state. In addition, there is a layer of reference posts that correspond to the actual reference posts on the highway (similar to mileposts), each of which has a unique number. Data is referenced to this system by specifying the route name, the post number, and the offset from the post.

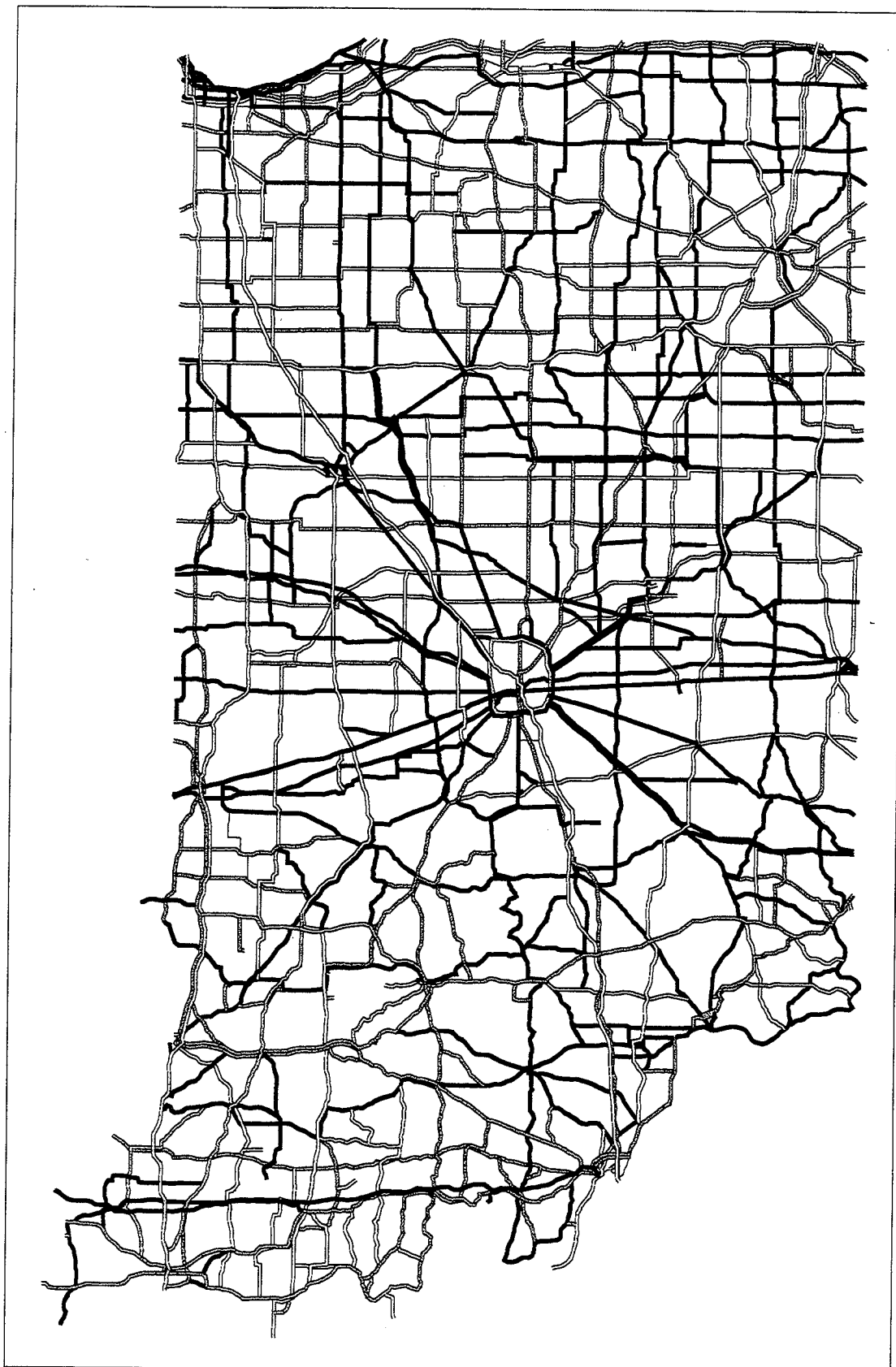


INDOT's extensive Road Inventory data set is referenced according to the County Log system. There is a larger and more detailed set of data available that uses the Reference Post system for the pavement management process. These include items such as posted speed limits, horizontal and vertical curvatures, bridge data, etc. The reference post route system is not fully operational (it would require a further and sizable clear-up effort). Since the reference post system was built upon the county log mile system, the log mile system was given top priority in the development process and is now fully operational. In order to get around the problem of using re-post data, a conversion program was developed by INDOT in cooperation with Caliper Corporation that translates re-posts to county log miles. A detailed set of instructions for the conversion procedure are available in the IMS Decision Support System documentation.

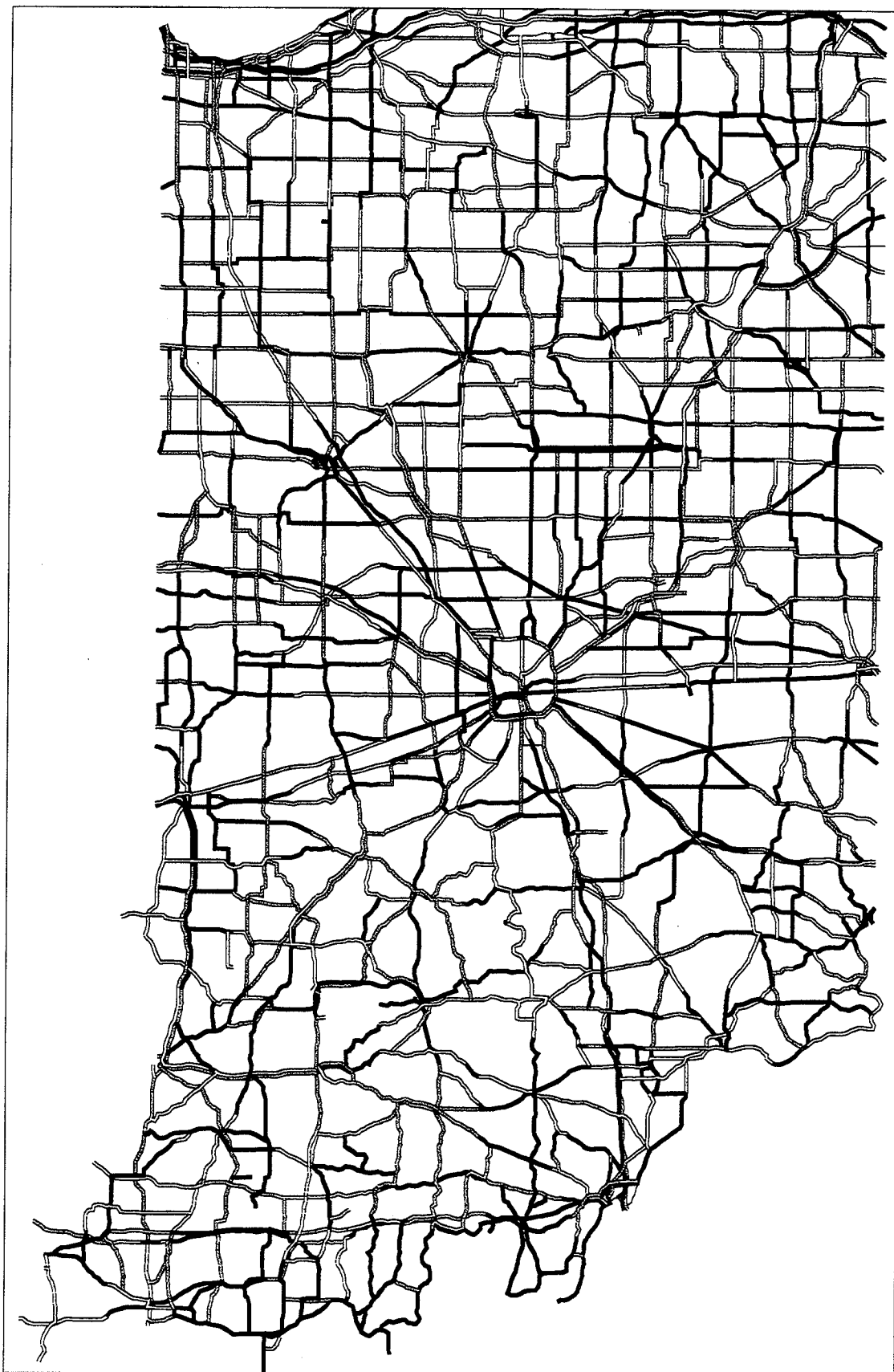
Both of INDOT's referencing systems are represented within the TransCad GIS as routing systems. The County log mile referencing system within TransCad was developed by GIS-Trans Ltd. The development of the County log mile system is documented in the technical memorandum "Development of the INDOT Statewide Intermodal GIS Road Centerline Database", dated December 21, 1995 and located in Appendix E at the end of this report. The reference post route system was developed by Caliper Corporation and built upon the County log mile system. Each is shown graphically on the next pages:

- Indiana Reference Post Route System
- Indiana County Log Mile System.

Indiana Reference Post Route System



Indiana County Log Mile Route System



The routing systems were reviewed extensively by INDOT, and both systems required extensive modification. Two on-site Caliper TransCad training sessions were held on September 1995 and April 1996, followed by two telephone conference training sessions. As part of the review process, Caliper conducted two route system editing training sessions for INDOT and members of the consulting team. The first session dealt with editing of route systems in general. The second session involved information specific to the attaching of reference posts to a route system. Written instructions for basic route system editing are available in the TransCad manual. Instructions for the second session were provided by Caliper. After the training, all route system modifications were completed by Professional Data Dimensions staff working in the INDOT office.

3.1.3 TransCad Add-ins

By attaching INDOT's data to the appropriate routing system it is possible to display information on-screen or to create maps within TransCad. However, for various modeling efforts that are underway or anticipated, it is necessary to join the data and geography into a single geographic file. Originally, it was thought that this could be accomplished by using a 'tagging' procedure in TransCad. This approach proved to be problematic. In response, Caliper created several new add-in procedures for TransCad. These procedures allow the user to combine milepost layers from different reference systems, to merge a milepost table with its underlying geography, to mark intersection nodes in a line database, and to remove non-intersection nodes from a line database.

3.1.4 GIS Layers

Once the base map and associated routing systems were developed it was possible to start adding the layers needed for the IMS geographic information system which are described below:

Base Map - The state highway network which is the basis for all other layers, as discussed in section 3.1.1.

County Log Mile Routing System - The TransCad routing system representation of the INDOT county log mile system, used to display data collected according to this linear referencing system, as described in section 3.1.2.

Reference Post Routing System - The TransCad routing system representation of the INDOT reference post system, used to attach data collected according to this linear referencing system, as described in section 3.1.2.

Road Inventory Data - INDOT road inventory data file that can be attached to the county log mile routing system. This file contains information on the basic road geometrics, functional classification, traffic counts, and so forth, for all Indiana highways. The file also contains some fields that are calculated from the basic data such as; assumed speed, peak hour traffic, capacity, etc. The road inventory data is documented in the "INDOT Road Inventory Computer Printout Supplement: A User's Guide".

Road Inventory Geographic Layer - INDOT road inventory data file merged with the county log mile routing system (using the add-in procedure) to create a geographic file containing all road inventory data and added fields.

Intermodal Facilities - Intermodal facilities of national or statewide significance. Airports were located according to latitude and longitude coordinates. Other facilities were geocoded according to their street address and then adjusted by manual digitization where necessary. Each facility has a unique identifier that can be used for attaching relevant data.

State/U.S. Access Links - The state highway system portion of the access link connecting the intermodal facility and the national highway. This layer was manually digitized using the base highway map as a guide. Each state/U.S. access link has a unique identifier (same ID as the facility) that can be used for attaching deficiency analysis data.

Local Access Links - The portion of the access link connecting the intermodal facility and the national highway that falls under local jurisdiction. This layer was manually digitized using the local streets layer (from the TransCad data CD-ROM) as a guide. Each local access link has a unique identifier (same ID as the facility) that can be used for attaching deficiency analysis data.

NHS Routes - This layer contains those highways that are designated to be part of the National Highway System for Indiana. The file was obtained by extracting only the NHS routes in Indiana from the National Highway Planning Network.

Rail Network - Railroad network of Indiana. This layer is extracted from the U.S. rail network file on the data CD-ROM that is included with TransCad.

Water Features - The layer contains all water blocks from the 1990 U.S. Census for the State of Indiana. This layer is extracted from the data CD-ROM that comes with TransCad. It is intended to be used only as a visual aid.

County Boundaries - Borders of Indiana counties. This layer is extracted from the U.S. counties file on the data CD-ROM that is included with TransCad. It is intended to be used only as a visual aid.

Census Place Boundaries - Borders of Indiana census designated places (cities and towns). This layer is extracted from the data CD-ROM that comes with TransCad. It is intended to be used only as a visual aid.

3.1.5 Federal Data Evaluation

Several federal agencies, including but not limited to FHWA, FTA, FRA and the Bureau of Transportation Statistics have recently engaged in an aggressive program to develop national modal and multi-modal databases to make them available upon request.

The purpose of the federal data evaluation task was to analyze the current state of these databases (especially the ones that are linked to GIS maps) to ascertain how useful they would be if ported onto the IMS decision support system.

The analysis and evaluation efforts concluded that though many of these federal databases contain valuable information, they were still in the development phase and thus could not be ported "cleanly" to INDOT's system.

A description of the analysis by database and source is attached to this final report in Appendix F. As the quality and consistency of these databases improve over time, INDOT should re-initiate its efforts to porting them and making them available to the planners in the agency.

3.2 User Interface

Development of the IMS provides the user immediate access to intermodal facility and access link data. Access links to the facility need to go one step beyond the State road inventory since in the majority of cases facilities are connected to the network via local streets. In addition, development of detailed access link databases provides the necessary framework for developing performance measures and identifying transportation deficiencies on the network. These databases are fully compatible with the Indiana Department of Transportation's TransCad system. The IMS user interface thus combines the following networks:

- Facilities

- Road network
 - National Highway System
 - State Road Inventory
 - IMS facility connections
- Rail network.

3.2.1 Facilities

The complete passenger and freight facilities inventory described in the previous chapter on the Network of Statewide Significance was loaded into TransCad by layer. The IMS team also loaded all facility attribute data so that it would be available to anyone manipulating the IMS.

The INDOT IMS has a total of eight intermodal facility layers (i.e., one for each facility type). By "calling up" any layer, the user places the intermodal facilities of statewide significance on a TransCad map. By clicking on any facility, a table will appear with the corresponding attribute and performance measurement information.

Both facility and access link tables include three types of field descriptors:

- Identifiers -- these are unique fields that describe the road access link or facility
- Performance measure fields -- these include all the calculated performance measures
- Other (supporting) fields -- these include fields that are used to calculate the performance measures and fields that do not directly impact performance measure calculations, yet provide useful information and were supplied by the MPOs and facility representatives.

For facilities, the identifiers include the facility unique identifier; name; address; latitude and longitude. Performance measure fields include the number of modes; transit frequency; parking utilization; bicycle racks; access to commercial service airports; on-dock rail; and containerization. Support fields include daily passenger and freight demand, among others. Please refer to Appendix G for a detailed Data Dictionary.

In order to compare attributes and performance measures across facilities, the IMS user can "jump" from one facility to the other. Performance measure calculations are further detailed in Chapter 4.

3.2.2 Road Network

Through TransCad, the user can access Indiana's road inventory. The inventory includes close to 12,000 segments that comprise the approximately 11,300 miles of State, US, and Interstate roads in the State. The National Highway System (NHS), with approximately 2,900 miles of roadway, forms a part of the road inventory and can be projected as such, or separately.

Access links between an intermodal facility and the NHS have two components. The first link - local roads - connects the facility to the nearest State/US road; the second - State/US roads - connects the local street(s) component to the NHS. This distinction is somewhat obscured by the fact that some State and US roads are already part of the NHS. When the nearest State/US road to a facility happens to be one of those NHS links, the access link to that facility includes just a local road component. Conversely, when an intermodal facility is located directly on a State road, its access link to the NHS does not contain a local road component.

With regards to the first link, local roads do not currently form part of the Indiana road inventory. To model this portion of the access link, the IMS team decided to digitize "stick" diagrams representing the local road portion. Accordingly, by clicking on a given stick diagram the user can access attribute and performance measure data for the entire local road link, as well as attribute data for each road composing that link.

By using a similar procedure, the IMS team tagged all State/US road segments forming the second link. This portion of the NHS access link is fairly obvious to the user since it represents a direct continuation of the stick diagram. By clicking on the State/US road link, the user will access attribute and performance data corresponding to each road composing that link. In the vast majority of cases there is only one road in this category, so multiple entries need not be considered. Please refer to maps on the following pages for depictions of the intermodal facility access links, and a detail map for a zoom view on the Elkhart facilities.

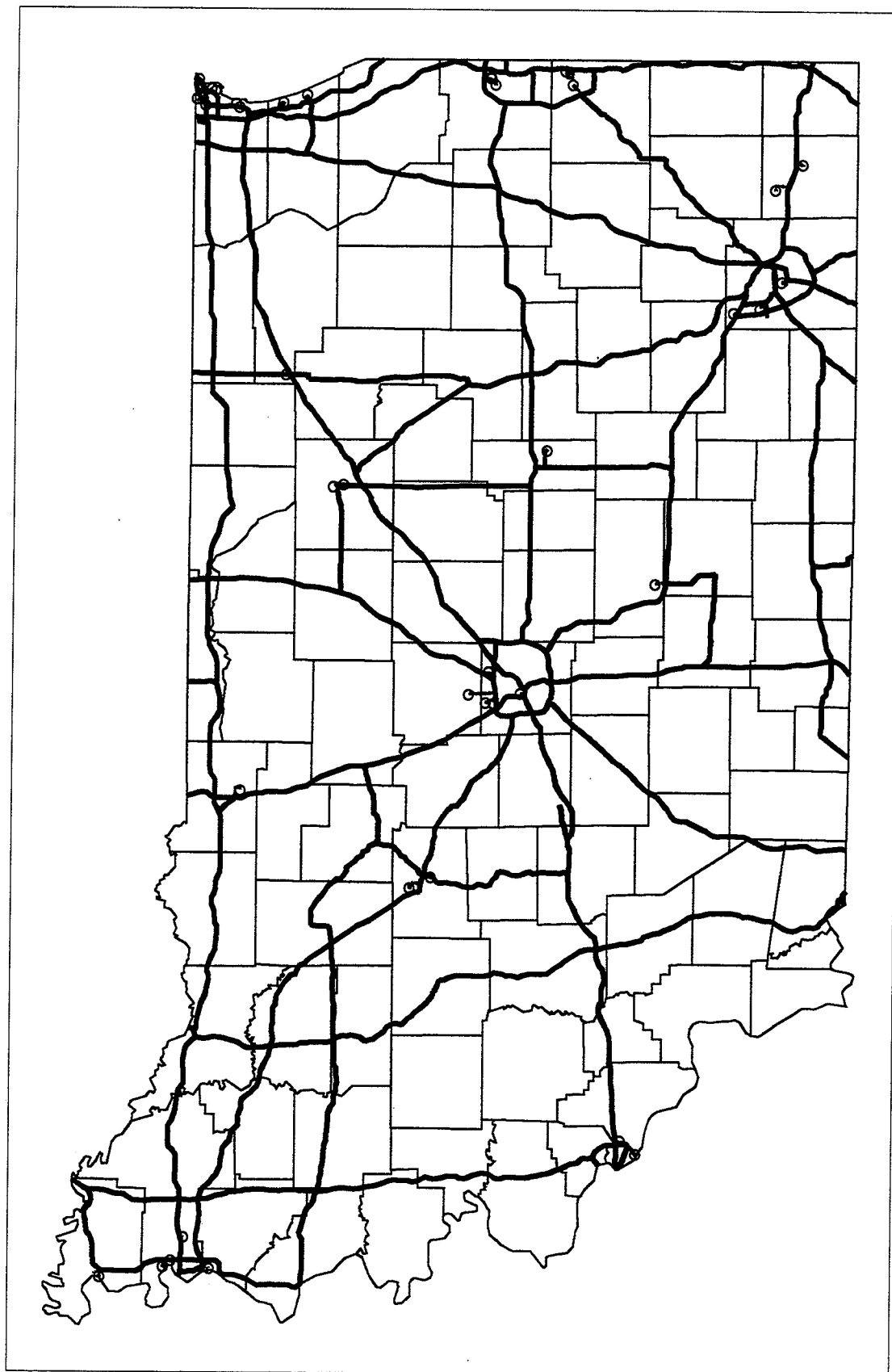
As is the case with facilities, the access link table fields have been regrouped into identifier, performance measure, and other supporting fields. Again, please refer to the Data Dictionary in Appendix G for a comprehensive listing of the fields included, as well as for the units used.

3.2.3 Rail Network

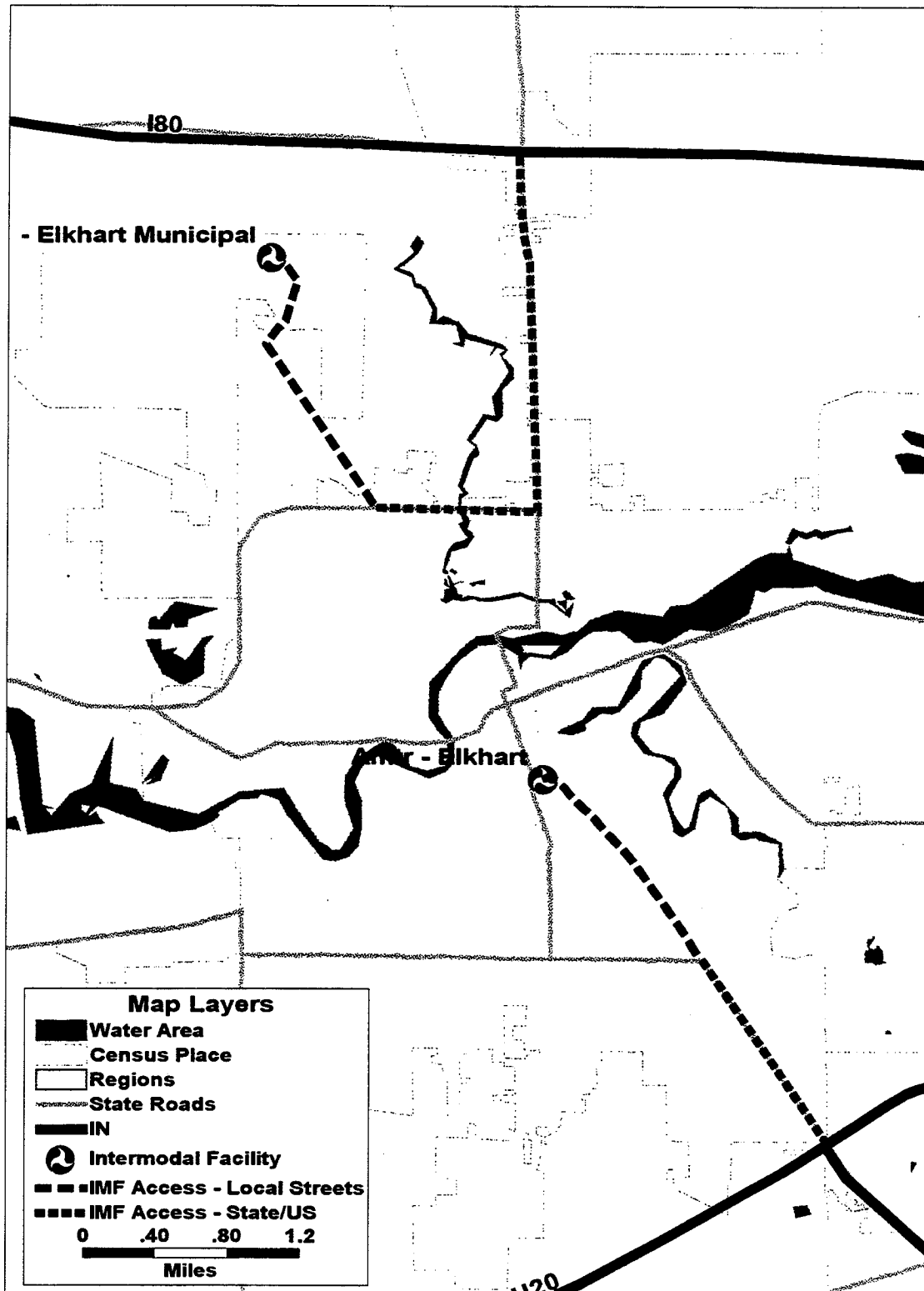
The second modal corridor network available to INDOT TransCad users is the rail network, shown at the back of this section. The rail network layer currently includes all Class I, II, and III railroads and can be added to the TransCad road network, the local and State/US access links, and the IMS facilities.

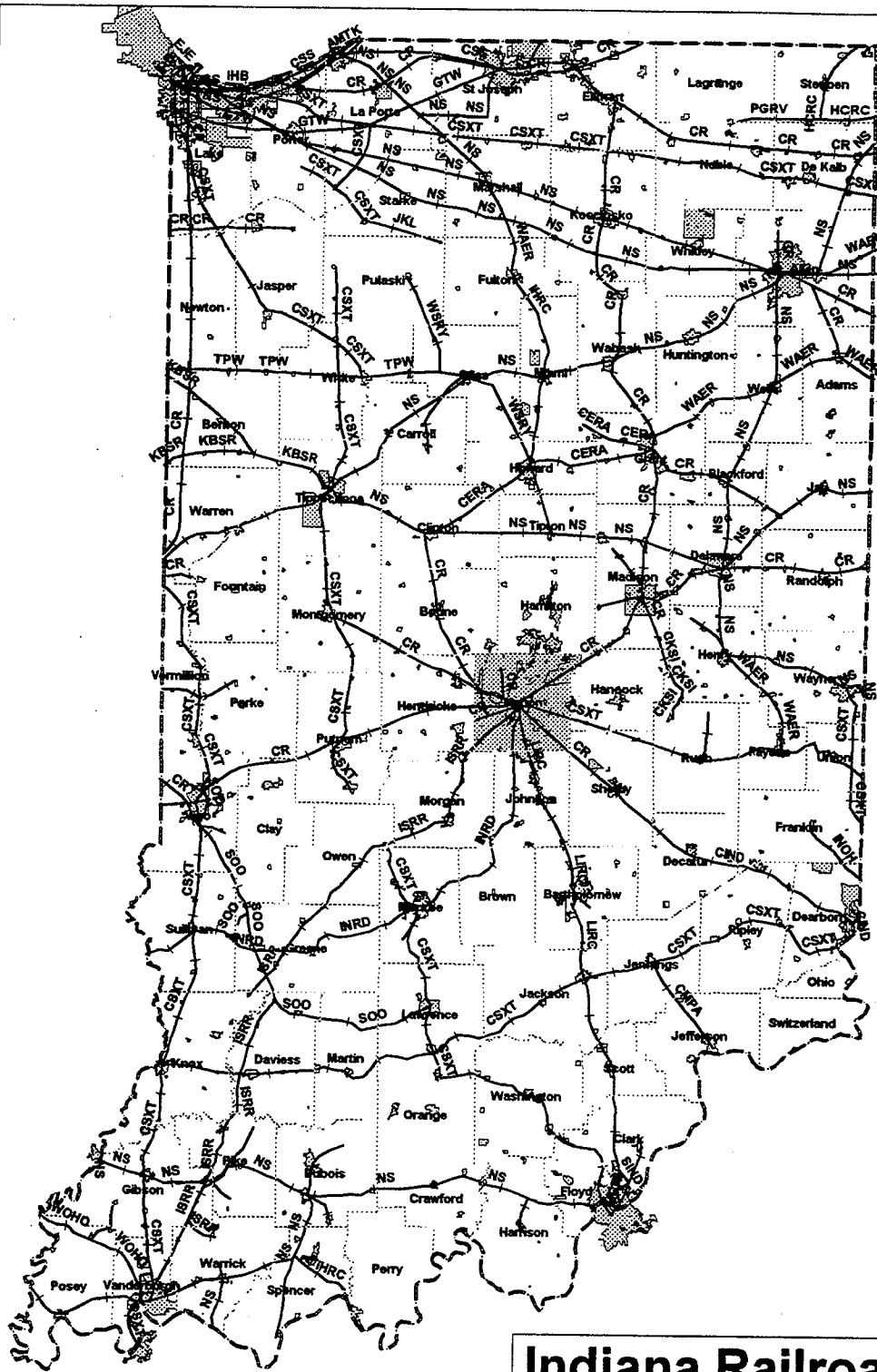
Freight flows and assignments are also available based on the work from Dr. Bill Black on Transport Flows in the State of Indiana. This is a part of the general discussion in Chapter 6, Freight Flows and Assignments.

Access Links to Intermodal Facilities



Access Links to Intermodal Facilities





Indiana Railroads

